The Elephant Rock, from the Survey to the Modelling

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Abstract

Methodology/Approach: In the northern part of Sardinia[1], in Italy, there is a unique volcanic stone[2]: natural forces have given the rock a strange elephant shape; ancient humans carved sepulchres for their dead; in the contemporary age, after centuries when the monument was lost and forgotten, the construction works of a new road brought the rock to light. This monument is a mix of natural and architectonic elements and it is a very interesting case study for any surveyor because it has a shape almost impossible to map with traditional measuring solutions. At the same time its strange and original shape gives no guaranties about the health status of this monument: if a small part should get lost it will not be easy to verify the real damage. Moreover the stone is now placed along a road and is freely accessible night and day without any kind of surveillance; so, what will happen in case of a car crash or in case of some tourist with a hammer and bad intentions?

Results: A complete survey of the shape of the rock was needed[3], so our survey laboratory attempted to produce a meaningful case study, tackling the 'unsurveyable' rock with contemporary laserscan technology and with our research experience. The work required only two days to be completed, producing an accurate laserscan survey integrated by a topographical network[4]. Here we present the first results of this work, where we define the real shape of this ancient monument in a specific moment, producing a useful archive which defines the definitive shape of the Elephant Rock at the beginning of the 21st century: from now on any transformation can be clearly verified as well any complete study can be developed starting from a very accurate three dimensional model.

Keywords

Sardinia, Italy, Digital survey, Laserscan, Modelling, ancient monument

1. The environment

Sardinia is the second biggest island of the Mediterranean Sea. It has been visited since pre-history and the first human settlements are dated back to 6000 BC. This central position gives to the island a special and strategic role from 3500 BC onwards.

Native cultures and foreign peoples choose this place to stay, to improve arts and to make commercial exchanges.

Pre-Nuragics, Nuragics, Phoenicians, Carthaginians, Romans, Byzantine, Arabs, Spaniards, and Italians colonized and ruled Sardinia during the centuries.

Considering the dynamics of the prehistorical context, the centrality of this island and the fact that Sardinia is a very ancient land, makes is possible to describe it as a meeting point for the different cultural flows which animated the Mediterranean Sea and it is possible to suppose it as a common cultural ground for the peoples in that area.

The historical development of the whole island is very interesting and very original; this is due to the particular solutions used by the ancient inhabitants. Sardinia's archaeological architectures have a strong relation with stone elements, and any ancient building is deeply connected to the capacity of interaction of the human operations with the landscape. Monuments

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1 In the inner parts of the island, near the town of Castelsardo.

2 Originally a volcanic rock, bigger than all the others which populate that area, rolled down the hill.

3 Until our survey operation on this monument, the existing survey takes care only of the horizontal and tranversal sections of the carved tombs; no documentation about the whole shape was provided before our intervention.

4 The Survey team undertaking this project was coordinated by Giorgio Verdiani, the laserscan operators were Sergio Di Tondo, Federico Piras, Giovanni Guccini and the topographical survey was operated by Francesco Tioli. Thanks to Filippo Susca for being always with us.

such as carved tombs, holy fountains, and nuraghes all share this charismatic aspect.

The Elephant Rock with its strong and particular shape is one of the more impressive finds of the pre-Nuragic era. The area of Castelsardo, where the Stone is placed, is rich in meaningful archaeological sites, and a lot of those sites are waiting for an extensive archaeological campaign.

It should be kept in mind that the archaeological heritage of Sardinia is huge, but just a little part of it has been studied and a smaller part has been the subject of researches operated using the technologies of our time.

Fig. 1. Relationship, and commercial exchanges across the ancient time.

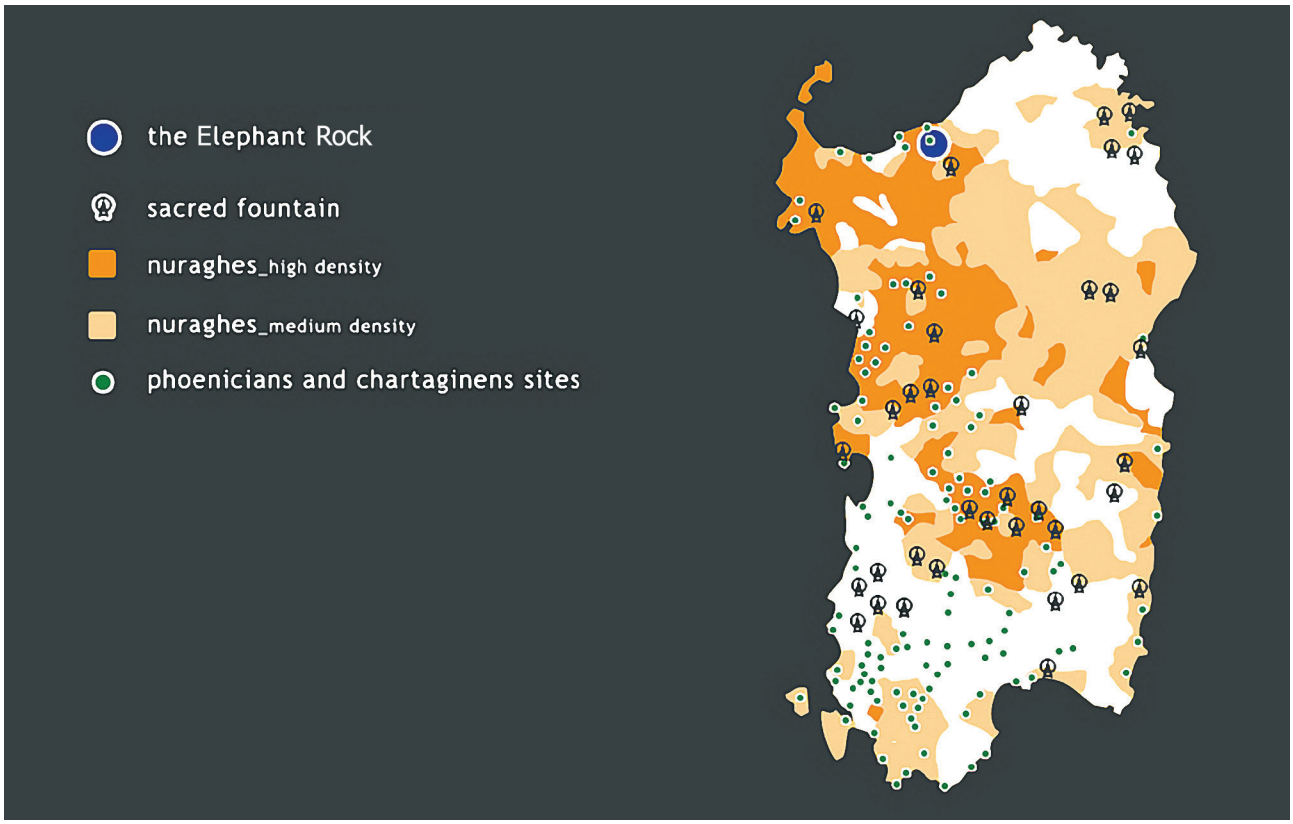

Fig. 2. Schematic map of the main archaeological finds in Sardinia, the Elephant Rock site is underlined in blue.

2. The Object

The Elephant Rock is a huge pyroclastic rock; probably it is rolled down the hill to stop exactly where it is now after some massive eruption. The special shape of the rock was created through the centuries by the weather agents; little by little the rock was eroded. It is not possible to say exactly when the rock acquired its actual shape, while it is possible to suppose that the works conducted by ancient men produced the falling of some large parts of the rock, bringing it, without any intention, to get the shape that resembles an elephant. The first to compare the rock to an elephant was E. Benetti; he used the words "enormous elephant" to describe the rock in his travel guide to Sardinia in 1914[5]. Before Benetti, the rock was known as "Sa petra pertunta" (the perforated stone) and the area where it is located had the same name. It is possible to find references about this name starting from the 12th century, but the first physical description of the monuments comes from the 19th century[6].

It has been one of the main symbols of the ancient Sardinia for years, but the work for the new road, passing in front of the monument, produced a heavy and brutal change in the landscape asset. Actually there is no real infrastructure to support the visits to the monument and there are no panels or other descriptive solutions to allow some knowledge behind the simple chance to take a look at the strange shaped rock. In this way all those that visit the rock still have something to learn or discover about it for themselves. The rock is characterized by a series of ancient tombs[7] carved in the rock on two levels, a

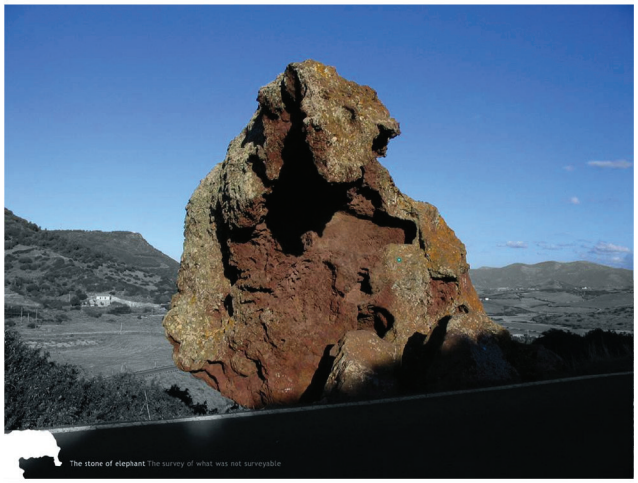

Fig. 3, 4, 5 and 6. View of the Elephant Rock during the survey of the November 2006. Only some decimetres separate the surface of the rock from the carriageway.

5 Benetti, E. Il sasso dell'elefante ed i simboli arcaici dell'agricoltura, published in "Sardegna!", number 1, 1914.

6 A more complete description about the documents describing the Rock can be found in Melis, P. La Domus dell'Elefante.

7 It is well-known that those Sardinian ancient graves, carved into stones are called "Domus de Janas" which means "Fairy House" accoding to the traditional belief that those places were used by mystical creature as their lair.

Fig. 7. View of the Elephant Rock during the survey of the November 2006. Parts of the stone and details of the ancient graves named "Domus de Janas".

large part of the rock is fallen on the ground probably a very long time ago and as related above, it is not easy to understand if this fracture happened during the cut of the tombs or later.

The group of the lower graves is the more interesting in this monument; this is due to the presence of a double engraved taurine head in the main tomb. The presence of this impressive sculptures and the fine artwork of carving demonstrate the high value of this place for the prehistorical society who worked to use this unique place as a part of their own tradition and culture.

3. The survey

Until today, this monument was not really surveyable as the strange shape and massive structure was a real problem for anyone who would try to realize a serious survey. Thanks to the laserscan technology this work became as easy as a complete photographical campaign. The Survey Laboratory of the "Dipartimento di Progettazione dell'Architettura" from the Florentine Architectural Faculty[8] undertook this project and began a self supported research project on this ancient rock. Previous surveys considered the tombs and did a good work, but they comprise a simple, classical bidimensional set of drawings; moreover it was aimed to document the ancient graves, and gave no information about the rock itself.

To face this work we chose to use a Leica HDS 3000 panoramic scanner, based on the time of flight technology. This was done for two reason: firstly, this scanner is capable to gather a very accurate set of points from a very short distance and this was a very important feature to allow the survey of the inner parts of the graves. Secondly, this scanner is also capable of gathering a very accurate result from a long distance, so it was possible to place the scanner in the upper parts of the hill in front of the rock and take the survey of the upper parts of the Elephant Rock with the same quality as the rest of the monument.

[8] The laboratory website is www.rilievo.org, for any information it is possible to use the E-mail: info@rilievo.org.

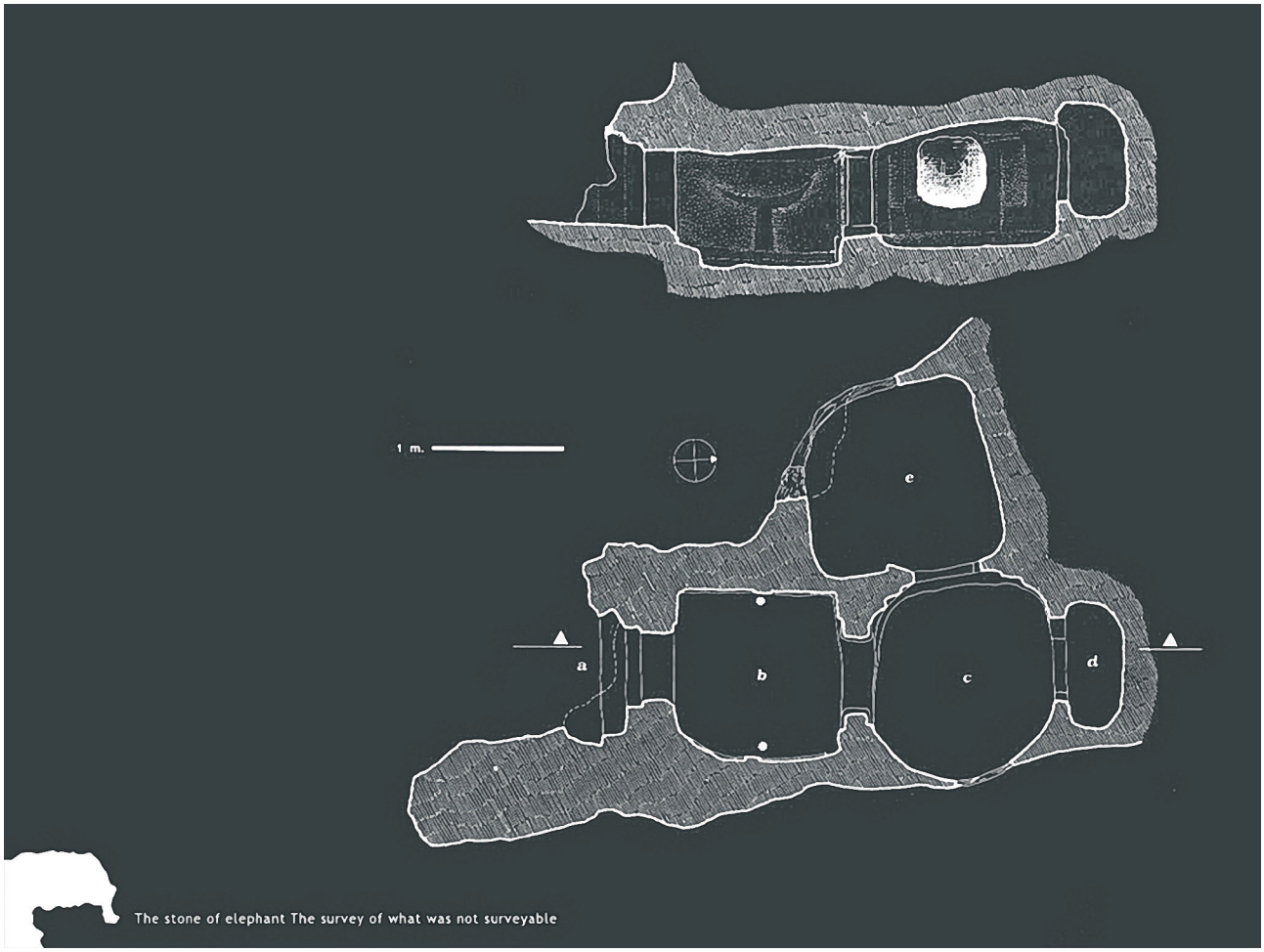

Fig. 8. State of the art of the survey of the rock before november 2006, sections applied on the lower tomb (from P. Melis).

Fig. 9. Working at the Rock survey: two days, ten scanner positions, a specific topographical network, twenty five millions of points gathered with a coverage of the ninety-five percent of the outer and inner surface.

To allow a high quality result in the overall operation the laserscan survey was supported by a complete topographical survey, aimed at building a specific network of all the special targets placed on the monument and absolutely necessary for a clean registration of the individual scans.

It is important to remember that the use of a topographical survey is not only fundamental because of the high level of accuracy in the registration process and for the better and easier scanning planning; it is important because when the topographical network is planned a series of permanent points are placed on the ground around the monument.

Those special points can remain placed in the site for many years; so if there is the need for a new survey, for example if it happens that a part of the monument is damaged, or for simple monitoring needs, it is possible to compare the two surveys according to points which are external to the monument. In fact it would be possible to survey additional data from any new position of the laserscan, and there will be no need to have a complete resurvey while a single part of the monument can also be measured again. The new survey can be placed exactly on the old one

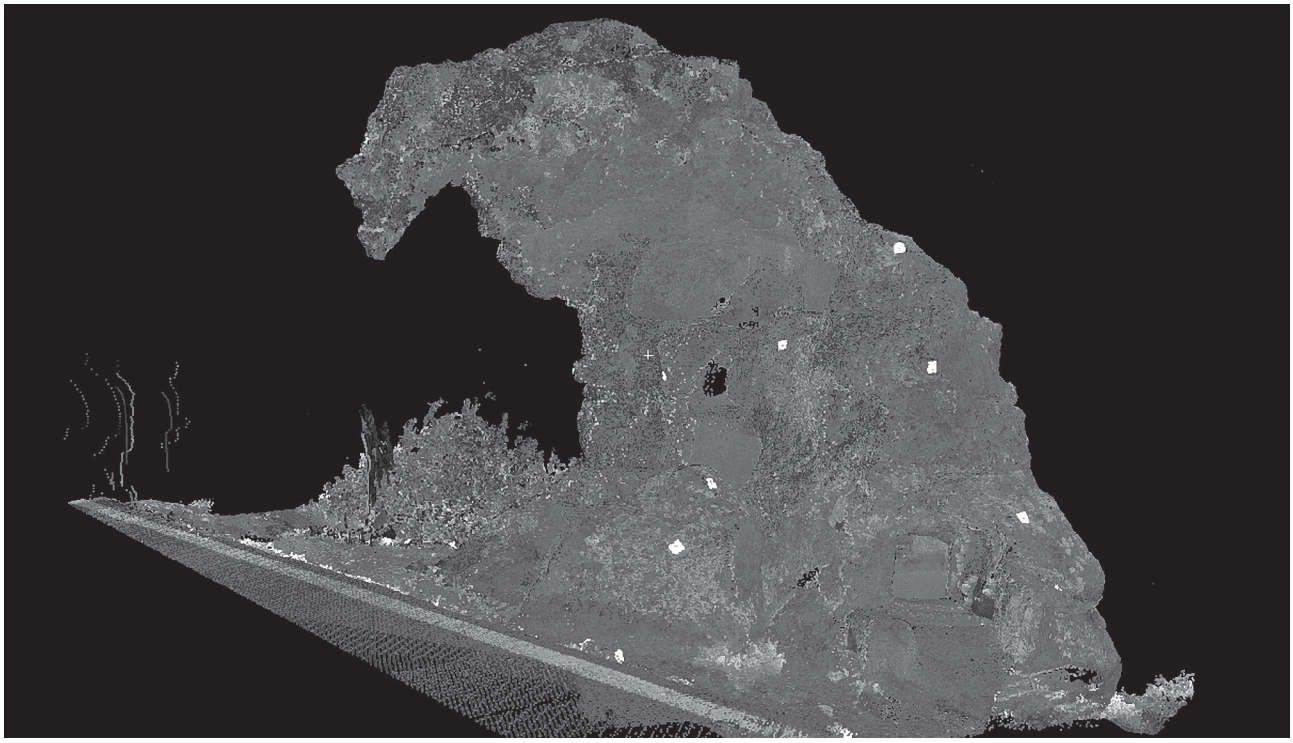

Fig. 10. View of the registered pointcloud in greyscale, the lighter square are the applied (removable) targets. Some human silouettes are left in the distance to give a measure reference to the image.

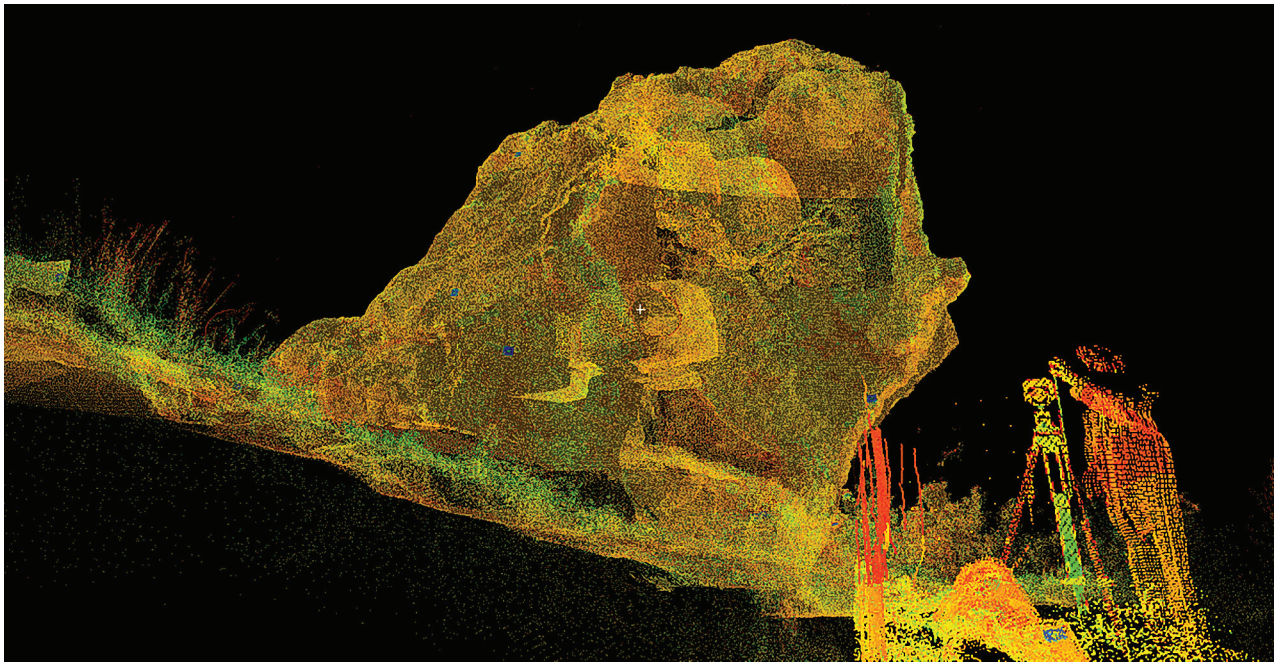

Fig. 11. View of the registered pointcloud in fake colours (reflectance values), the blue squares are the applied (removable) targets. On the right, Francesco Tioli while operating the topographical survey.

according to the topographical survey, based on some of the old points left on the area during the first digital survey.

Some more information about the survey campaign: the survey was completed in two single days, the scan stations operated were twelve, with almost twenty five million points collected.

The accuracy obtained was around six millimetres per point for all the scans. When the scanner was placed inside the graves the use of a wireless access point was very useful to have a remote control of the scanner from the outside[9].

The topographical network was based on six topographical stations and took the survey of the almost forty targets applied on the stone and removed at the end of the whole scanning session.

4. First data treatments

The first step in the treatment of the gathered data was, as usual, the registration of all the single scans in a unique digital model. This was done following two classical criteria for this kind of survey: first, the single pointclouds were registered over the topographical survey, then they were geometrically compared (using the "cloud constrain" function in Leica Cyclone) to improve the alignment of each pointcloud over the other.

After the registration, the next operation upon the resulting pointcloud aimed to produce some simple sections all around the monument and an initial, simplified surface model with almost all the occlusion holes fixed. The whole first treatment aimed to produce a massive, basic model of the monument. This was a first surface model useful to verify the quality of the gathered data. On the surface digital model a first texturing treatment was applied to have

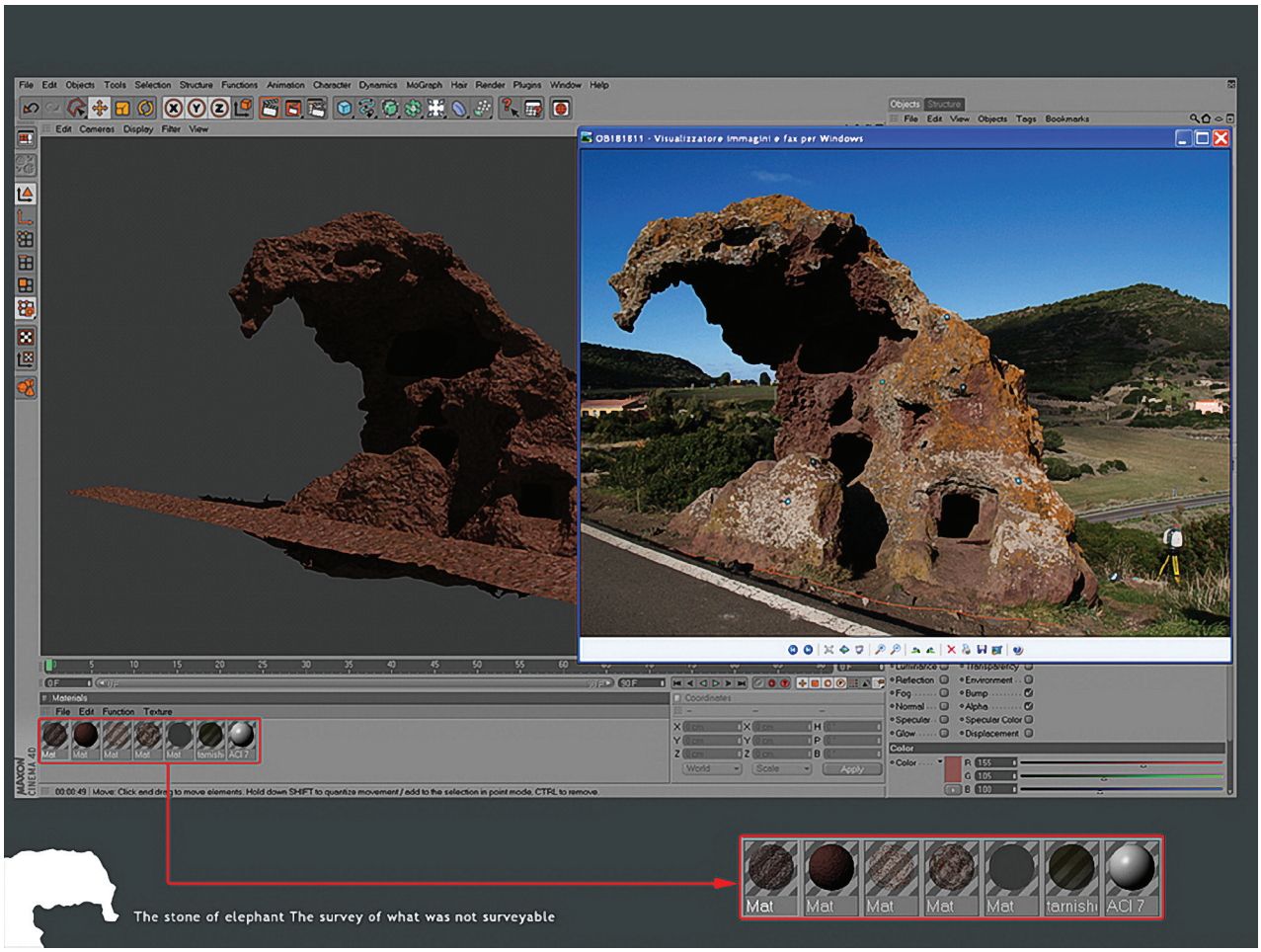

Fig. 12. After the surface digital model is done, some rendering operations can be started to produce a more realistic divulgative model of the monument. Here the operations are executed using Maxon Cinema 4D.

[9] The access point hardware was connect to the scanner with a cable and the access point itself was placed out of the grave to allow a better wireless efficiency and a lower number of occlusions in the scanning operations.

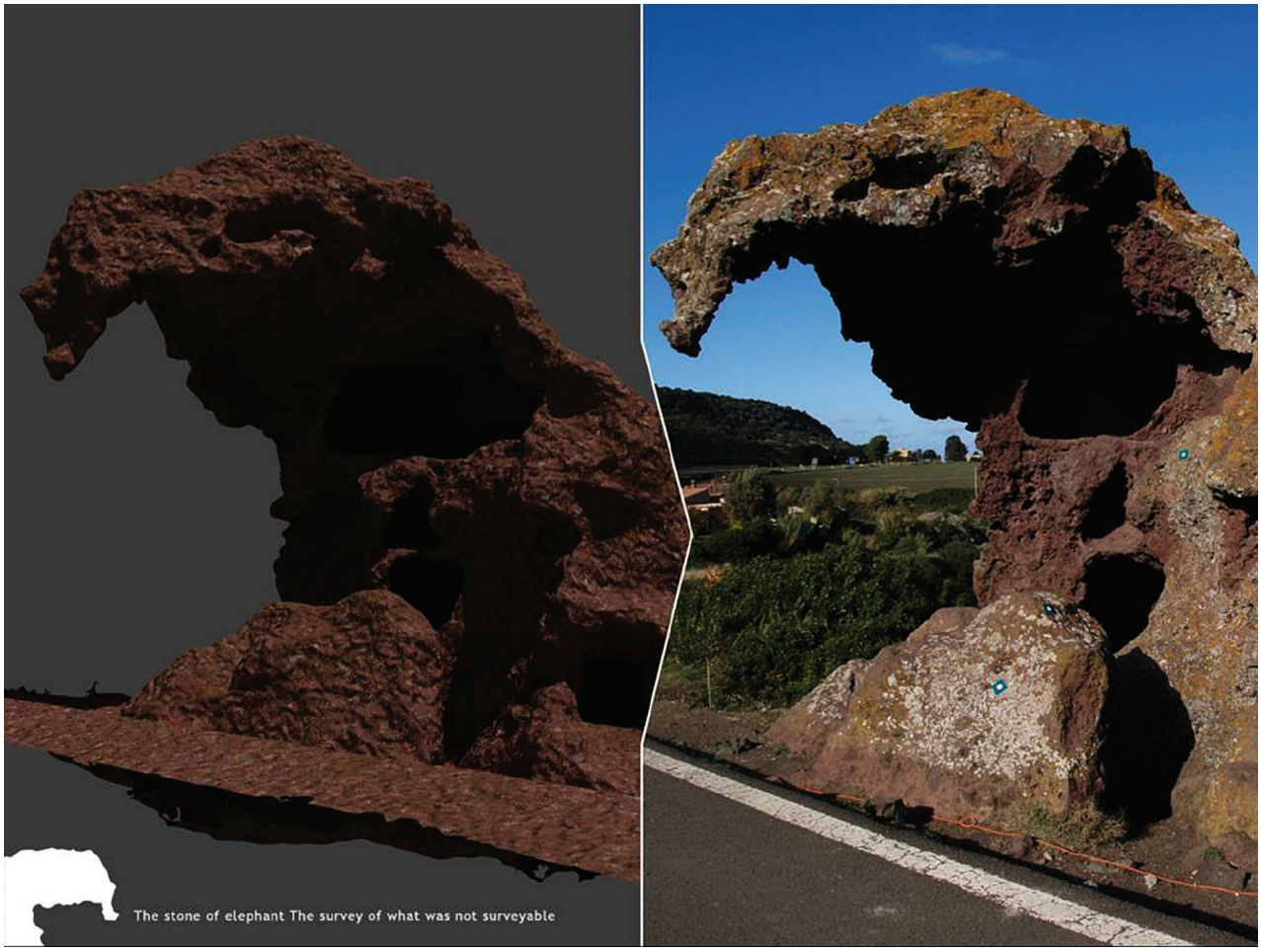

Fig. 13. On the left the 3D digital model in a rendering view with a generic "pyroclastic" rock material applied. On the right the real rock during the days of the survey.

a better evaluation of the result. Bringing this model to a generic rendering software like Cinema 4D also allowed testing how versatile the obtained model was. In this software it was possible to produce a series of rendering views of the digital model and it was possible to use this environment to develop some 3D interactive simulations to allow a better sharing of the first result without the need to share the heavy and hard to manage surface 3D model.

The 3D interactive simulations were developed using the Quicktime VR output, a pre-compiled system of visualization capable of making a full virtual space perceptible, with a visualization based on a pre-calculated series of frames. The overall effect is quite good, allowing a good sight on the whole model and a quick exploration of the shape of the monument without any need of complex navigation systems.

Obviously this is just a simple, first test to verify the quality of the survey, while the whole project is planned to achieve a more complex structure, this structure is explained in *Fig. 14*.

The whole process is aimed to produce three main results, each result integrating the other:

The first result is to have a very high quality survey of the monument, useful as a precious documentation of the conditions of the rock in November 2006.

The second result is to produce divulgative models and interpretative models to enhance the possibility of using and sharing of the knowledge of this important monument.

The third result is to build a rich set of information, which will be avaible as a starting point for the enhancement of the knowledge about this ancient patrimony and as an incentive to the research on this awesome area.

5. Conclusion

The geographical distribution of settlements linked to the different cultures which visited and colonized Sardinia shows the existence of a partial and sometimes total territorial overlap of this sites and cultures during the historical evolution. This fact confirms that it is possible to describe a place as a "hot spot", a valiance acting as a reference to the intrinsic characteristics of the sites, like the visibility

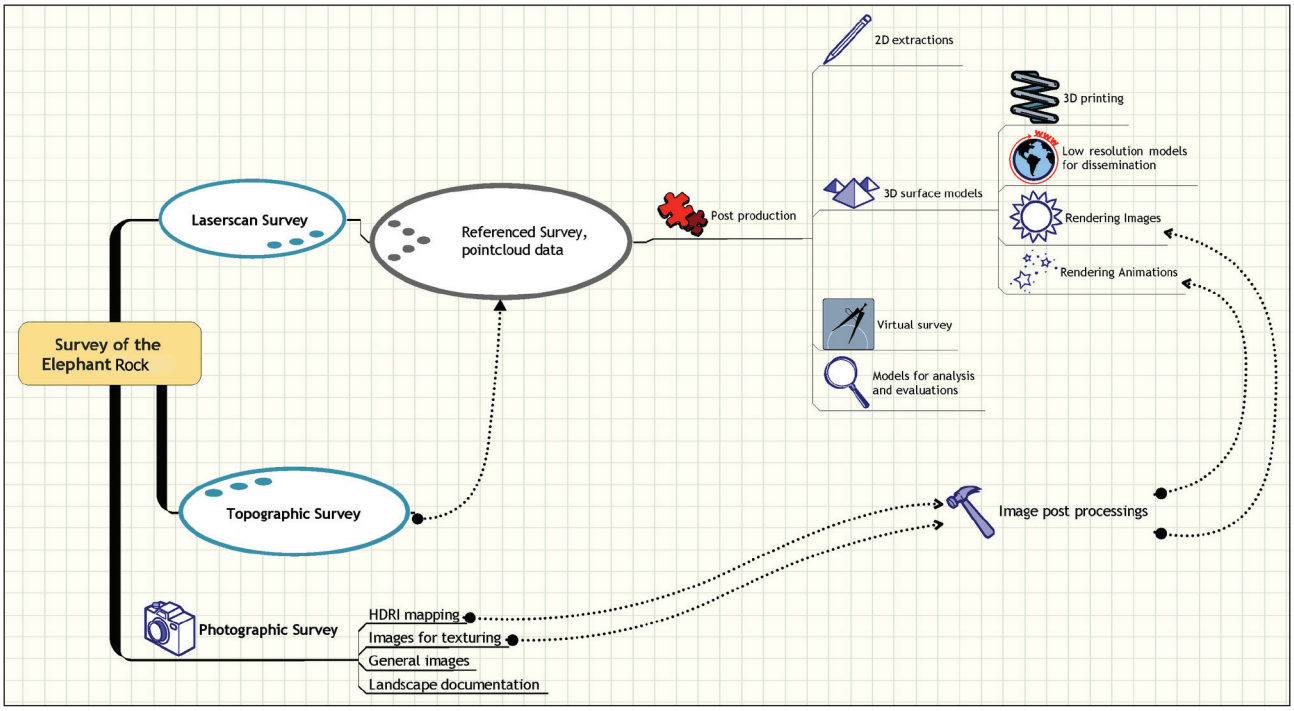

Fig. 14. The general study and research workflow planned for the Elephant Rock survey. All the branches are actually under development.

and the strategic functionality. The Elephant Rock clearly demonstrates this.

The analysis of the sites where the rock is situated shows that this place was important and attended during the third millennium BC.

The rock is lovated just in the point where the road towards the direction of Nuraghe Paddaghiu, a relevant Nuragic fortress rounded by a village, and the megalithic fortress of Monte Ossoni meet the connection with the carved burial site of Sedini and the path arriving from the natural docking place of Cala Ostina. There is no doubt that this place was a relevant meeting point of human flows.

So it is possible to consider the of the Elephant Rock as an emblematic territorial landmark, a powerful symbol of this territory, today as in 3000 BC.

The work presented here proposes the start of a cooperation between digital survey technology and archaeological knowledge to produce a better

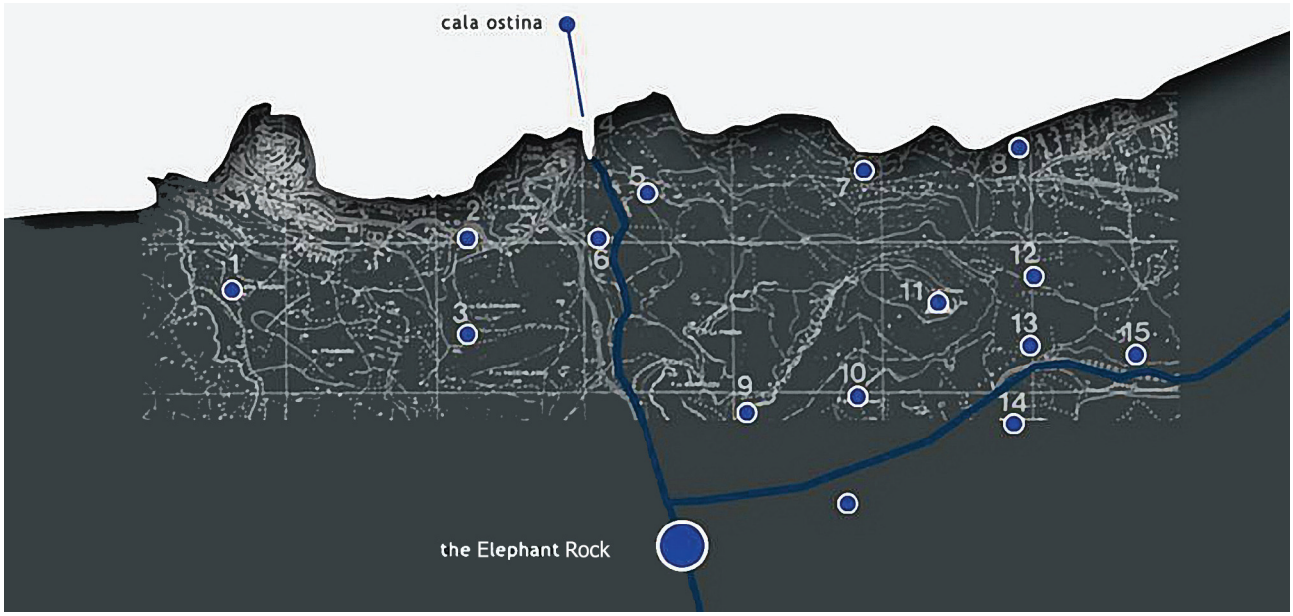

Fig. 15. Map of the ancient area where the Rock is located. The numbers indicate the other meaningful archaeological finds.

understanding of the historical and symbolic value of this impressive expression of Sardinia's culture.

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